

What is claimed is:

1 1. A method for forming a trench capacitor, comprising:
2 providing a semiconductor substrate, wherein a deep
3 trench and a deep trench capacitor are formed
4 therein, the deep trench capacitor having a node
5 dielectric layer and a storage node, the node
6 dielectric layer covering a sidewall and a bottom
7 portion between the deep trench and the deep trench
8 capacitor, and the storage node filling the deep
9 trench to a predetermined depth;
10 ion implanting the top portion of the deep trench to a
11 predetermined angle to form an ion doped area on
12 a single sidewall of the semiconductor substrate
13 and the top surface of the deep trench capacitor;
14 oxidizing the semiconductor substrate to form an oxide
15 layer on the ion doped area;
16 forming a sidewall layer on the exposed semiconductor
17 substrate using the oxide layer as a mask;
18 removing the oxide layer;
19 forming a barrier layer on the sidewall of the deep trench;
20 and
21 filling a conducting layer in the deep trench.

1 2. The method for forming a trench capacitor of claim
2 1, wherein the ion source of the ion implantation is a gas
3 mixture containing F, which promotes growth of the oxide layer.

1 3. The method for forming a trench capacitor of claim
2 2, wherein the gas mixture containing F is fluorine gas.

1 4. The method for forming a trench capacitor of claim
2 1, wherein the sidewall layer is an epi-silicon layer.

1 5. The method for forming a trench capacitor of claim
2 1, wherein the material of the sidewall layer is the same as
3 the semiconductor substrate.

1 6. The method for forming a trench capacitor of claim
2 1, wherein the barrier layer is an oxide layer or a nitride
3 layer.

1 7. The method for forming a trench capacitor of claim
2 1, wherein the conducting layer is a poly layer.

1 8. The method for forming a trench capacitor of claim
2 1, wherein the node dielectric layer is a silicon nitride layer.

1 9. The method for forming a trench capacitor of claim
2 1, wherein the storage node is an n+ type doped poly.

1 10. A method for forming a trench capacitor, comprising:
2 providing a semiconductor substrate, wherein a deep
3 trench and a deep trench capacitor are formed
4 therein, the deep trench capacitor having a node
5 dielectric layer and a storage node, the node
6 dielectric layer covering a sidewall and a bottom
7 portion between the deep trench and the deep trench
8 capacitor, the storage node filling the deep trench
9 to a predetermined depth, and the deep trench has
10 a first sidewall and a second sidewall;
11 ion implanting the deep trench top portion to a
12 predetermined angle to form an ion doped area on

the semiconductor substrate of the first sidewall
and the top surface of the deep trench capacitor;
oxidizing the semiconductor substrate to form a first
oxide layer on the ion doped area and a second oxide
layer on the second sidewall, wherein the thickness
of the first oxide layer exceeds the second oxide
layer;
removing the second oxide layer to expose the
semiconductor substrate of the second sidewall of
the deep trench;
forming a sidewall layer on the second sidewall using
the first oxide layer as a mask;
removing the first oxide layer to expose the semiconductor
substrate of the first sidewall;
conformally forming a first barrier layer on the first
sidewall, the sidewall layer, and the deep
capacitor;
forming spacers on the first sidewall and a sidewall of
the sidewall layer sequentially;
filling a first conducting layer in the deep trench;
etching back the first conducting layer and the spacer
to a predetermined depth; and
conformally forming a second barrier layer on the first
sidewall, the sidewall layer, and the first
conducting layer, and the deep trench being filled
with a second conducting layer.

11. The method for forming a trench capacitor of claim
10, wherein the ion source of the ion implantation is a gas
mixture containing F, which promotes growth of the oxide layer.

1 12. The method for forming a trench capacitor of claim
2 11, wherein the gas mixture containing F is fluorine gas.

1 13. The method for forming a trench capacitor of claim
2 10, wherein the sidewall layer is an epi-silicon layer.

1 14. The method for forming a trench capacitor of claim
2 10, wherein the material of the sidewall layer is the same
3 as the semiconductor substrate.

1 15. The method for forming a trench capacitor of claim
2 10, wherein the first barrier layer is a nitride layer.

1 16. The method for forming a trench capacitor of claim
2 10, wherein the spacer is an oxide layer or a nitride layer.

1 17. The method for forming a trench capacitor of claim
2 10, wherein the first conducting layer is a poly layer.

1 18. The method for forming a trench capacitor of claim
2 10, wherein the second barrier layer is a nitride layer.

1 19. The method for forming a trench capacitor of claim
2 10, wherein the second conducting layer is a poly layer.

1 20. The method for forming a trench capacitor of claim
2 10, wherein the node dielectric layer is a nitride silicon
3 layer.

1 21. The method for forming a trench capacitor of claim
2 1, wherein the storage node is n+ type doped poly.